

UNITED STATES SIGNAL SERVICE

MONTHLY WEATHER REVIEW.

VOL. XVI.

WASHINGTON CITY, MAY, 1888.

No. 5.

INTRODUCTION.

This REVIEW treats generally the meteorological conditions of the United States and Canada for May, 1888, and is based upon the reports of regular and voluntary observers of both countries. Descriptions of the storms that occurred over the north Atlantic Ocean are also given, and their approximate paths shown on chart i, on which also appears the distribution of icebergs and field-ice and the limits of fog-belts west of the fortieth meridian.

Except over the northern and central plateau districts and the north Pacific coast region, where the mean temperatures exceeded the normal from 2° to 5° , the month was colder than the average May in all parts of the United States, the region of greatest deficiency of temperature being the upper Mississippi valley, where the means ranged from 6° to 9° below the normal.

The rainfall for May was largely deficient in the Rio Grande Valley, extreme northwest, and on the Pacific coast; it was also below the average in Florida, the lower lakes, middle slope, and middle and northern plateau districts, but the deficiencies in these latter districts were less marked than in those first named. In New England, the middle Atlantic and east Gulf states, the upper Mississippi and Missouri valleys, and northern slope there was a large excess over the average rainfall.

A destructive flood prevailed in the upper Mississippi river during the first and second decades of the month, causing extensive loss of property in the towns and cities along its banks in the states of Minnesota, Wisconsin, Iowa, Missouri, and Illinois.

In the preparation of this REVIEW the following data, received up to June 20, 1888, have been used, viz., the regular tri-daily weather-charts, containing data of simultaneous observations taken at 133 Signal Service stations and 23 Canadian stations, as telegraphed to this office; 177 monthly journals and 175 monthly means from the former and 23 monthly means from the latter; 352 monthly registers from voluntary observers; 60 monthly registers from United States Army post surgeons; marine records; international simultaneous observations; marine reports through the co-operation of the Hydrographic Office, United States Navy, and the "New York Herald Weather Service;" monthly weather reports from the local weather services of Alabama, Arkansas, Colorado, Illinois, Indiana, Kansas, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New England, New Jersey, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, and Tennessee, and the Central Pacific Railway Company; trustworthy newspaper extracts, and special reports.

ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean pressure for May, 1888, determined from the tri-daily telegraphic observations of the Signal Service, is shown by isobarometric lines on chart ii. The isobar of 30.00, showing the regions of greatest mean pressure for May, 1888, extends along the Atlantic coast from Florida to Nova Scotia, the station reporting the maximum mean pressure, 30.04, being Hatteras, N. C. In all other regions covered by the observations the mean pressure was below 30.00, with the exception of a single station, viz., Tatoosh Island, Wash., where the mean just reached that figure. The region of minimum mean pressure embraces the southern Rocky Mountain and plateau districts, where the pressure falls below 29.85.

The departures from the normal pressure at the various Signal Service stations are given in the table of miscellaneous meteorological data. Comparison with the normal pressure shows a deficiency in all parts of the country, with the exception of the extreme northwest, New England, and the Maritime Provinces of Canada, where there was a slight excess, generally less than .05. The deficiencies range from .05 to .10 over about one-half of the entire country, being most marked on the north Pacific coast. While the mean pressure for this month was for the most part below the normal, the preceding month was characterized by unusually high mean pressure over nearly the whole country.

The barometric means of April and May, 1888, compared, shows the latter to range .10 to .20 below the former over

nearly the whole country, the decrease being most marked over the region from the Great Lakes to the Gulf of Mexico. A very slight increase is shown over the Gulf of Saint Lawrence.

BAROMETRIC RANGES.

The monthly barometric ranges at the various Signal Service stations are also given in the table of miscellaneous meteorological data. The ranges, as usual, conform to the general rule; that is, they increase with the latitude and decrease slightly, though somewhat irregularly, with increasing longitude. In the states bordering on the Atlantic the extreme ranges were .33 at Key West, Fla., and .61 at Block Island, R. I.; between the eighty-fifth and one hundredth meridians, .36 at Galveston, Tex., and 1.05 at Marquette, Mich.; eastern slope of the Rocky Mountains, .46 at Fort Davis, Tex., and 1.01 at Denver, Colo.; plateau region, .35 at Fort Grant, Ariz., and .77 at Fort Bridger, Wyo.; Pacific coast, .28 at San Diego, Cal., and .60 at Portland, Oregon. The ranges for this month over the whole country differ but slightly from the normal.

AREAS OF HIGH PRESSURE.

Five well-defined areas of high pressure were observed during the month of May, three of which approached the north Pacific coast from west to southwest, and, after being retarded while the centre of greatest pressure was near the coast line, moved to the eastward of the Rocky Mountains in a direction

to the south of east, passing over the eastern slope of the Rocky Mountains, where the easterly movement was again retarded, after which the movement to the Atlantic coast was rapid and more directly to the eastward. Two areas of high pressure were first observed in British America, one of which probably originated over the north Pacific. Both of these areas passed over the Saint Lawrence to the Atlantic, moving directly to the eastward.

The following table shows the approximate latitude and longitude in which the centre of each area of high pressure was first and last observed, the highest observed barometer reading attending each, and the average rate of movement in miles per hour:

Number of area.	First observed.		Last observed.		Highest observed barometer reading.	Average hourly movement.
	Lat. N.	Long. W.	Lat. N.	Long. W.		
I.....	51 00	87 00	45 00	59 00	30.34	11.0
II.....	48 00	126 00	36 00	70 00	30.48	27.0
III.....	42 00	127 00	34 00	93 00	30.26	19.0
IV.....	52 00	114 00	46 00	65 00	30.36	31.0
V.....	44 00	128 00	37 00	102 00	30.20	17.0
						25.0

Average rate of progress, 22.0 miles per hour.

I.—This area of high pressure covered the northern part of the Lake region on the 1st of the month; it extended southward, covering the entire portion of the United States east of the Mississippi River, while the centre moved eastward over the Saint Lawrence Valley during the 2d, 3d, and 4th. It was preceded immediately to the eastward by a well-defined area of low pressure to the eastward of Nova Scotia, and was followed by a storm of considerable energy in the Lake region, while the ridge of high pressure extended from the Saint Lawrence Valley southward along the Atlantic coast to Florida. The pressure increased until the area had passed the seventy-second meridian, after which it decreased slowly as the area moved eastward over the north Atlantic in advance of the storm in the Lake region. This area of high pressure was attended by fair weather and cool northerly winds over the greater part of the east portion of the United States during the first three days of the month, except in New England, where it was preceded by rain, turning to snow.

II.—This area approached the north Pacific coast from the westward, and was central near the mouth of the Columbia River on the morning of the 4th. It remained almost stationary in this region until after the morning of the 5th, when it was apparently reinforced from the region north of Montana, and an extended area of high pressure formed, covering the Lake region, Minnesota, Dakota, and the northern Rocky Mountain region during the 6th and 7th. A well-defined low area moved northeastward from Texas to the central valleys while this high area extended over the northern portion of the United States, and the cold northerly winds in the northern quadrants of the storm were attended by very heavy rains during the 7th and 8th, the belt of rain extending from Kansas and Nebraska eastward to the Atlantic coast, the heaviest rains occurring in the central valleys. This area passed southeastward over the Saint Lawrence Valley and the middle Atlantic states on the 8th, the pressure decreasing with the easterly movement. It was still observed to the east of Hatteras, N. C., at midnight of the 9th. Heavy rains occurred in Florida, and general rains throughout the south Atlantic states while this area was central to the east of Hatteras.

III.—This area of high pressure was first observed to the west of northern California on the 8th, moving northeastward from the region of permanent high pressure in the Pacific. It advanced over this course until the centre had apparently reached the mouth of the Columbia River, where it remained almost stationary until the morning of the 11th, after which it moved southeastward and covered the central Rocky Mountains on the morning of the 12th, replacing an area of low pressure

which was central in that region on the 11th. After passing to the eastward of the Rocky Mountains, this area extended, covering the central valleys from the Gulf to the British possessions. Two areas of high pressure formed on the eastern slope during the 12th, one of which covered northern Texas, and the other the upper Missouri valley. The pressure within the former decreased and the area disappeared after passing over the lower Mississippi valley on the 13th, while the pressure increased in the Northwest and the last-named area moved to the southeastward, following the general course of the Missouri Valley during the 13th and 14th, the pressure diminishing during the southeasterly movement until the night of the 15th, when it had passed over the Southern States and was central to the eastward of Florida.

IV.—This area of high pressure appeared to the northward of Montana on the 15th, while an extended area of low pressure covered the central Rocky Mountain and plateau regions. The southeasterly movement of this area of high pressure during the 15th apparently forced the eastern portion of the low area to the southward over Texas, leaving a well-defined area of low pressure over the central plateau regions. This high area extended eastward during the 16th and 17th, covering the central valleys and Lake region, and on the morning of the 17th the centre of greatest pressure was north of Minnesota, while a secondary area of high pressure formed over the middle Atlantic states. The disturbance previously referred to as covering the central plateau regions on the 15th moved slowly southeastward to northern Texas and, afterwards, rapidly to the northeast, apparently dividing the area of high pressure, the eastern portion of which moved off the middle Atlantic coast and the northern portion, or principal area of high pressure, moving southward in rear of the dividing storm. It was central in Nebraska and covered the eastern slope of the Rocky Mountains on the 18th, after which it moved eastward, following the general course of the low area which preceded it, until it reached the Saint Lawrence Valley on the 21st. It covered the greater portion of the United States east of the Rocky Mountains while central within the limits of the stations of observations. It passed eastward over New England during the 22d, after which its course was apparently northeastward.

V.—This area of high pressure was observed westward of Oregon on the 26th, apparently moving slowly northeastward from the Pacific. Its centre reached the coast line of Washington Territory on the morning of the 27th, when the barometer was high over the northern plateau and northern Rocky Mountain regions, and an area of low pressure covered the lower Missouri valley. After reaching the Oregon coast the direction of movement changed to the southeast, and in the next twenty-four hours it had extended over the Rocky Mountain regions and was central in Colorado. The southeasterly movement continued until the 29th, the pressure diminishing while the area extended over the eastern slope of the Rocky Mountains and central valleys, after which it disappeared. It was last located as a well-defined area of high pressure central in northern Texas on the 29th.

AREAS OF LOW PRESSURE.

Ten areas of low pressure were observed within the limits of the United States during the month of May. The region of greatest storm frequency extended from northern Texas and Colorado northeastward to Lake Michigan, and while no barometric depressions have been traced from the Pacific coast eastward, more than one-half of the disturbances observed during the month were preceded by extended depressions over the plateau regions. Two areas of low pressure were first observed north of Idaho and moved southeastward over the eastern slope of the Rocky Mountains but did not develop sufficient energy to reach the Atlantic coast, and one low area was observed off the middle Atlantic coast, moving northeastward.

From chart i it will be seen that no decided storm passed over the Southern States and that only one slight disturbance was traced along the Atlantic coast, while the five distur-

ances traced eastward of the Mississippi River moved north-eastward to the west of the Saint Lawrence River, not reaching the Atlantic within the limits of observation.

The following table shows the latitude and longitude in which each area of low pressure was first and last observed, the lowest pressure observed within each area, and the average velocity in miles per hour:

Number of area.	First observed.		Last observed.		Lowest observed barometer reading.	Average hourly velocity.
	Lat. N.	Long. W.	Lat. N.	Long. W.		
I.	40 15	72 00	43 45	61 30	29.60	43.3
II.	41 20	117 00	49 45	86 00	29.36	21.0
III.	38 00	104 40	42 00	86 45	29.56	16.7
IV.	52 50	116 00	50 45	91 15	29.22	16.0
V.	40 00	91 25	48 30	78 00	29.40	41.7
VI.	53 00	114 45	35 40	89 30	29.60	36.4
VII.	40 20	112 25	44 20	75 00	29.48	27.8
VIII.	39 20	102 30	44 20	92 45	29.64	21.2
IX.	40 00	86 00	45 40	80 45	29.68	18.2
X.	39 10	110 00	47 30	73 00	29.2	26.0

Average rate of progress, 26.8 miles per hour.

I.—This storm originated in northern Texas during the preceding month and moved northeastward over the Ohio Valley and middle Atlantic states, where it was central on the morning of the 1st, the disturbance extending over New England, the middle Atlantic states, and the lower lake region. After reaching the coast line it moved rapidly northeastward, developing considerable energy in the vicinity of Eastport, Me., where the barometer fell to the minimum, 29.60, on the afternoon of the 1st. From this point the centre moved more to the eastward, and it disappeared over the Atlantic during the 2d. It was followed in New England by rain and snow and this by cold, clearing weather during the 2d.

II.—This area of low pressure was central over northern Nevada at the last report of the preceding month. It passed to the eastward of the Rocky Mountains during the 1st, and on the 2d it appeared as a well-marked elliptical depression, extending from northern Texas to Iowa, bounded by the isobars of 29.5, 29.6, and 29.7. Heavy rains occurred in the northern half of this disturbance, as it covered the regions between the Mississippi River and Rocky Mountains. It moved in the direction of its longer axis during the 3d, becoming circular in form and contracting upon reaching the upper Mississippi valley. The barometer rose slightly at the centre during the northeasterly movement, the lowest pressure, 29.36, being observed in western Kansas on the 2d. The northeasterly course continued during the 3d and 4th, when it passed north of the Lake region, followed by strong westerly winds at lake stations. This storm apparently reached its maximum energy while passing over Wisconsin, although the barometer was rising at the centre of the disturbance.

III.—Number iii was central over southern Colorado and New Mexico on the 6th, and apparently resulted from an extended area of low pressure which covered the plateau regions on the 4th and 5th. Local rains occurred throughout the southern portion of the Rocky Mountain regions on the 5th, and very heavy rains occurred over the eastern slope of the Rocky Mountains from Texas to the Missouri Valley during the 6th. The course of this disturbance was first southward from Colorado to Texas, and afterwards to the northeastward to eastern Kansas, when it became extended, covering the central valleys and causing heavy rains from the lower lake region westward to the Missouri Valley. Heavy rains were also reported on the Gulf coast while this disturbance was central near Saint Louis, Mo. After reaching southern Michigan this disturbance disappeared by gradual increase of pressure. The centre was last observed on the morning of the 9th in southern Wisconsin, having been apparently drawn to the northwestward by a second disturbance which was then moving eastward north of the upper Missouri valley.

IV.—On the morning of the 8th this disturbance was central to the north of Montana and it moved southeastward to north-

ern Dakota during the succeeding twenty-four hours, after which it receded to the northward and moved eastward, the pressure at the centre falling to 29.22 near the centre on the morning of the 10th. The trough of low pressure extended over the eastern slope of the Rocky Mountains while the principal disturbance remained to the north of Manitoba. A secondary disturbance was formed within the southern portion of this barometric trough, which, after remaining central in the vicinity of northern Texas on the 10th and 11th, apparently filled up by a high area from the Rocky Mountain regions, while a second formed in the upper Mississippi valley on the 11th and has been traced as number v.

V.—This area of low pressure covered the Lake region, attended by general rains throughout the the Northern States on the 11th and 12th. It moved northeastward with increasing energy, the barometer reaching the minimum, 29.30, while the disturbance was passing over the northern portion of Lake Huron. Areas of high pressure were observed to the east and west of this low area within the limits of the weather chart. Heavy rains occurred in New England during the 12th, attended by brisk easterly winds, and in the Lake region brisk and high westerly winds and clearing weather prevailed on the same date. This storm disappeared to the north of the Lake region on the 13th, leaving secondary disturbances along the New England and middle Atlantic coasts, which were attended by light rains and brisk to high winds until the 15th.

VI.—This storm developed north of Montana and moved southward over the eastern slope of the Rocky Mountains during the 14th and 15th. Its course was almost directly southward from the upper Missouri valley to northern Texas, where it was central on the afternoon of the 15th. It apparently formed the eastern portion of an extended low area which covered the plateau regions, and was followed in its southerly movement by an area of high pressure which followed directly in the track of its centre and apparently forced this depression to the southward. After the centre reached the latitude of 35° the depression extended eastward to the Mississippi Valley, where it disappeared. The minimum pressure was observed when this area was central over northern Texas, at the point where the direction changed from northerly to easterly.

VII.—This disturbance formed in the western half of the depression which covered the plateau and Rocky Mountain regions and from which the low area previously described developed. It remained central over Utah and Colorado for forty-eight hours, moving slowly southeastward. It crossed to the east slope of the Rocky Mountains on the 17th, preceded by heavy rains throughout the Northwest. It changed direction to the northeast after reaching northern Texas on the 17th, and extended over the central valleys, attended by general rains except in the east Gulf and south Atlantic states. The rains were heavy in the west Gulf states after the winds shifted to the north and the disturbance moved northeastward with slowly increasing pressure at the centre, and was more marked as an area of rain, and the depression apparently lost energy during the easterly movement. It moved northeastward over the Saint Lawrence Valley and probably disappeared to the eastward on the 22d.

VIII and IX.—This storm also developed over the central plateau region, where it was central on the 20th and 21st, but no definite movement of the centre could be traced until a secondary area formed to the eastward in Colorado on the 22d. This secondary disturbance moved to the northeastward to the upper Mississippi valley, leaving a depression over the central plateau region. The barometer was generally low over the central valleys, and this disturbance became less clearly defined by bounding isobars until it disappeared by increase of pressure in the upper Mississippi valley. Within the extended trough of low pressure above referred to, the disturbance traced as number ix developed on the 25th. Heavy rains occurred throughout the Lake region and in the northern portion of the states of the Ohio Valley while this disturbance

moved over Lakes Erie and Huron, and it disappeared to the northward on the 26th.

X.—This area of low pressure was central in Utah on the afternoon of the 25th, and moved southeastward to northern Texas, where it was central on the morning of the 26th. It moved northeastward from this position with decreasing pressure at the centre until it reached the Mississippi Valley, and it was attended by heavy rains generally throughout the Northern States, lower Mississippi valley, and west Gulf states. It remained almost stationary in the upper Mississippi

valley during the 27th, after which it extended northeastward and moved rapidly over the Lake region to the Saint Lawrence Valley. The minimum pressure, 29.42, was observed while this area was central near Keokuk, Iowa, on the afternoon of the 27th. This condition was followed by a slight increase of pressure at the centre during the easterly movement until the storm had passed over the Lake region, after which the pressure at the centre fell again to 29.42, accompanied by strong westerly gales in the lower lake region. The disturbance disappeared to the northeast on the 30th.

NORTH ATLANTIC STORMS FOR MAY, 1888.

[Pressure in inches and millimetres; wind-force by Beaufort scale.]

The paths of the depressions that appeared over the north Atlantic Ocean during May, 1888, have been determined from international simultaneous observations by captains of ocean steamships and sailing vessels, received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Eleven depressions have been traced, of which six advanced eastward over northern Newfoundland; three first appeared over mid-ocean; one apparently developed west of the British Isles; and one moved northwestward from the Caribbean Sea into the Gulf of Mexico. The general direction of movement of the depressions was east-northeast, although, in instances, marked irregularities in their advance was shown. One depression traversed the ocean from coast to coast. The month opened with unsettled and stormy weather over the entire ocean. The depression central over Ireland April 30th had moved northeasterly over Scotland, attended by barometric pressure falling below 29.00 (736.6); a storm of great energy was central over mid-ocean, while off the American coast, in the vicinity of the fortieth parallel, a disturbance of moderate strength appeared. From the 2d to the 6th there was an apparent transition of high barometric pressure from the Azores to the British Isles, during which period a depression moved northeastward from south of Nova Scotia and disappeared in the direction of Iceland. From the 6th to the 10th high barometric pressure and fair weather prevailed over the eastern portion of the ocean, while in the vicinity of Newfoundland the passage of two depressions of small energy occasioned moderate to fresh gales. During the last half of the second decade of the month stormy weather prevailed over the British Isles, attending the irregular movements of a depression to the westward; to the westward of the fortieth meridian the weather was changeable, with frequent and marked barometric fluctuations. During the third decade the barometer continued high east of the thirtieth meridian until the 26th, from which date until the 30th, inclusive, stormy weather prevailed in that region. From the 21st to the 24th a storm of pronounced energy moved eastward over the Banks of Newfoundland from the Gulf of Mexico, and thence passed northward toward Greenland. The latter portion of the month was chiefly characterized by the passage of a depression from the Gulf of Mexico to the British Isles. The storm which is given a probable track from the Caribbean Sea into the Gulf of Mexico from the 9th to the 11th, while unimportant as regards strength, would seem to indicate the development of meteorological conditions in the tropical north Atlantic favorable for the summer cyclones peculiar to that region.

In May, 1887, eleven depressions were traced, of which two traversed the ocean from coast to coast; one originated over the Caribbean Sea and moved northward over Cuba; one first appeared south of Bermuda and advanced northward; one passed eastward from the American coast in about N. 41° and subsequently moved northward; four developed to the southward or southeastward of Nova Scotia or Newfoundland; one was first charted northeast of Newfoundland; and two appeared within the region of observation in European waters, one hav-

ing advanced from the southwest and the other from the northwest. The general direction of movement of the depressions was east-northeast to the eastward of the fortieth meridian, while to the westward of that longitude the tracks were greatly diversified as regards position and direction. The general character of the weather over the ocean was seasonable, and the depressions which appeared corresponded closely with the average for the month as regards position, number, and direction of movement. The severest disturbances prevailed over mid-ocean from the 22d to the 25th, inclusive.

The depressions of May, 1888, were of about normal intensity, and in distribution, number, and direction of movement, corresponded with the average for the month.

In the following descriptions of the depressions traced, positions are given in degrees, latitude and longitude, except in cases where twenty-five to thirty-five minutes are cited, when they are shown in degrees and half degrees:

1.—This depression was central on the 1st in about N. 52°, W. 27°, with barometric minimum about 29.20 (741.7), whence it advanced to N. 57°, W. 17°, by the 2d, after which it passed to the north of the British Isles, with fresh to strong gales.

2.—This depression occupied the ocean off the American coast in the vicinity of the forty-first parallel on the 1st, whence it moved east-northeast to the sixtieth meridian by the 2d, in which locality it remained nearly stationary until the 3d; by the 4th the storm-centre had passed northward to Newfoundland, subsequent to which date it recurved south of east and then advanced rapidly northeastward and disappeared in the direction of Iceland after the 6th. This storm developed marked energy while traversing Newfoundland and the Grand Banks, where barometric pressure falling below 29.60 (751.8) was shown.

3.—This was a depression of moderate energy which passed eastward from the Gulf of Saint Lawrence during the 7th, and on the 8th was central northeast of Newfoundland, from which position the storm-centre moved northeast and disappeared north of the region of observation after the 9th.

4.—The presence of this depression over or near the western portion of Cuba was indicated by reports of the 9th, to which locality it had apparently advanced from the Caribbean Sea; by the 10th the centre of depression had moved westward, and its approximated position on that date was to the northward of Yucatan; by the 11th the storm-centre had passed to the westward of the ninetieth meridian, after which its course cannot be determined by reports at hand. The limited data received from the region through which this disturbance passed, while indicating its small strength and probable track, will not admit of a more accurate definition of its characteristics.

5.—This depression passed southeast from the Gulf of Saint Lawrence during the 9th and on the morning of the 10th was central southeast of Newfoundland, with barometric pressure about 29.60 (751.8); by the 11th the centre of disturbance had moved northeast to N. 50°, W. 41°, with a marked decrease in central pressure. On this and the following date an area of high barometric pressure occupied the ocean east of the thirtieth meridian and had the apparent effect of deflecting the